STOPPING WATER POLLUTION AT ITS SOURCE

MISA
Municipal/Industrial Strategy for Abatement

COST ESTIMATES AND IMPLICATIONS OF THE EFFLUENT MONITORING – GENERAL AND EFFLUENT MONITORING – PETROLEUM REFINING SECTOR REGULATIONS FOR ONTARIO'S PETROLEUM REFINERIES

Environment Ontario

Jim Bradley
Minister

ISBN 0-7729-4323-0

MUNICIPAL-INDUSTRIAL STRATEGY FOR ABATEMENT

COST ESTIMATES AND IMPLICATIONS OF THE "EFFLUENT MONITORING - GENERAL" AND "EFFLUENT MONITORING - PETROLEUM REFINING SECTOR" REGULATIONS FOR ONTARIO'S PETROLEUM REFINERIES

Socio-Economic Section
Policy and Planning Branch
Corporate Resources Division

JULY 1988

(Reprinted: November 1989)

TABLE OF CONTENTS

		Page No.
LIST OF TABLES		iii
ABSTRACT		iv
SOMMAIRE		vi
1.	BACKGROUND AND PURPOSE OF REPORT	1
	1.1 MISA Objectives	1
	1.2 Monitoring Regulations for Ontario's Petroleum Refineries	2
	1.3 Purpose of the Present Report	3
	1.4 Cost Estimation Methodology	4
	1.5 Plan of Report	6
2.	MONITORING PROCEDURES AND REQUIREMENTS	7
	2.1 Components and Functions of Monitoring	7
	2.2 Sampling Requirements	7
	2.3 Flow Measurement	9
	2.4 Characterization Analyses	13
	2.5 Routine Analyses	14
	2.6 Toxicity Testing	14
	2.7 Reporting and Administration	16
	2.8 Pre-Regulation Consultation and Meetings	16
	2.9 Recommendations of the MISA Advisory Committee (MAC)	18
3.	MONITORING COST ESTIMATES	19
	3.1 Comprehensiveness and Accuracy	19
	3.2 Timing	19
	3.3 Sampling Facilities	20
	3.4 Flow Measurement	23
	3.5 Characterization Analyses	25
	3.6 Routine Analyses	27
	3.7 Toxicity Testing	28
	3.8 Reporting, Administration and Contingencies	29
	3.9 Regulation Development	29
	3.10 Total Costs of the MISA Petroleum Refining Sector Monitoring Requirements	31
	3.11 Financial Impacts of Monitoring Costs	33

Page No.

4. CONCLUSIONS AND RECOMMENDATIONS 36

4.1 Conclusions 36
4.2 Recommendations 37

REFERENCES 38

LIST OF TABLES

Table	Title	Page No.
2.1	Sampling Requirements for Petroleum Refinery Effluent Monitoring	10
2.2	Requirements for Flow Measurement under the Petroleum Refinery Effluent Monitoring Regulation	11
2.3	Summary of Existing Flow Measurement Devices at Each Refinery	12
2.4	Frequencies of Routine Analyses and Analytical Test Groups to be Analysed ...	15
2.5	Number of Rainbow Trout and Daphnia Magna Toxicity Tests Required for Each Refinery	17
3.1	Automatic Sampling Facilities Cost Estimates	22
3.2	Flow Measurement Cost Estimates	24
3.3	Average Ontario Commercial Laboratory Prices for Analytical Test Groups	26
3.4	Summary of Capital Cost Estimates for Each Refinery	30
3.5	Summary MISA Petroleum Refinery Monitoring Costs - Point Estimates	32
3.6	Financial Impacts of Estimated Monitoring Costs on the Consolidated Petroleum Products Segment of Petroleum Companies .	34

ABSTRACT

Point and range estimates of the incremental capital and operating costs to Ontario's refineries of implementing monitoring regulations under the MISA program are derived and summarized.

Six key monitoring activities or functions were identified:

- sampling;
- flow measurement;
- characterization analyses;
- routine analyses;
- toxicity testing; and
- reporting and administration.

The total capital cost of complying with the monitoring regulation ranges from $1 million to $2 million with a point estimate of $1.6 million. Of this amount, $208,700 or 13% of the point estimate, is designated for automated flow measurement and sampling facilities on intake water points. Sampling and analyses of intake water is not expressly required by the regulations but is deemed necessary in order to determine net loadings from each refinery.

Automated sampling and flow measurement equipment are being installed on virtually all wastewater sampling points in order to avoid recurring labour costs that would be associated with other methods of obtaining these measurements.

Total operating costs for 12 months over the 18-month period of the regulations are estimated to range from $2 million to $2.3 million. About $145,000 would be spent to carry out characterization, routine and toxicity testing on intake water.

An analysis of selected financial impacts was performed on the consolidated financial performance of the petroleum products segment of each oil company except Petrosar. Financial data necessary to conduct these analyses were not available for Petrosar.

The oil industry views the extra costs of the regulations as a necessary cost of doing business.

The extra capital costs amount to between 0.06% and 1.86% of the lowest annual capital expenditure reported by each firm since 1981.

The extra operating costs amount to between 0.4% and 1.4% of the lowest annual after-tax profits experienced by 4 of the companies between 1981 and 1985.

Extra operating costs amount to 33% of one firm's unusually low profits in 1984 and would have increased another firm's total loss between 1983 and 1985 by 1%.

SOMMAIRE

Le présent rapport donne l'estimation des dépenses d'exploitation et d'immobilisations qu'entraînera, pour les raffineries de l'Ontario, l'application des réglements sur la surveillance des effluents dans le cadre de la Stratégie municipale et industriells de dépollution.

Les six champs suivants ont été examinés:

- l'échantillonnage;
- la mesure de l'écoulement;
- les analyses de caractérisation;
- les analyses de routine;
- les tests de toxicité;
- la présentation de rapports et la gestion.

Les dépenses d'immobilisations entraînées par les mesures de dépollution vont de un million à deux milions de dollars; la moyenne s'établissant à 1,6 million. De cette somme, 208 700 $, ou 13 %, seront affectés au mesurage automatisé de l'écoulement et à l'échantillonnage de l'eau aux points d'arrivée. L'échantillonnage et l'analyse de ces effluents ne sont pas obligatoires d'aprés les réglements, mais il semble qu'ils soient nécessaires pour pouvoir déterminer la charge nette rejetée par chaque raffinerie.

On aménage à l'heure actuelle des appareils automatisés d'échantillonnage et de mesure de l'écoulement à quasiment tous les points de déversement des eaux usées. Ainsi, les raffineries pourront épargner les coûts de main-d'oeuvre associés aux autres méthodes.

On estime que les coûts d'exploitation totaux pour 12 mois, pendant la période de 18 mois que durera la mise en application des réglements, varieront entre 2 millions et 2,3 millions de dollars. Les raffineries consacreront environ 145 000 $ aux analyses de routine et de caractérisation ainsi qu'aux tests de toxicité.

Par ailleurs, on a analysé certaines des répercussions économiques qu'auront de telles mesures sur le rendement financier consolidé du secteur des produits dérivés du pétrole de chaque société, à l'exclusion de la Petrosar. Dans ce dernier cas, on n'a pu obtenir les données nécessaires pour effectuer les analyses.

l'industrie pétroliére considére que les dépenses supplémentaires entraînées par les réglements provinciaux sont parfaitement justifiées dans le cadre de leurs activités.

Les coûts d'immobilisations supplémentaires représentent de o,06 % à 1,86 % des dépenses d'immobilisations annuelles les plus basses signalées par les sociétés depuis 1981.

Quant aux coûts d'exploitation supplémentaires, ils représentent de 0,4 % à 1,4 % des bénéfices aprés impôts les plus bas de quatre sociétés entre 1981 et 1985.

Ils représentent, d'autre part, 33 % des bénéfices anormalement bas signalés par l'une des sociétes en 1984. Elles auraient haussé de un pour cent les pertes totales subies par une autre société entre 1983 et 1985.

1.0 BACKGROUND AND PURPOSE OF REPORT

1.1 MISA Objectives

The Ontario Ministry of the Environment (MOE) has launched the Municipal-Industrial Strategy for Abatement (MISA). The primary intent of the Program is to achieve the "virtual elimination of toxic contaminants in municipal and industrial discharges into waterways" (Ontario Ministry of the Environment, June 1986).

The MISA Program consists of three broad components:

1. Development and promulgation of Regulations which specify contaminant monitoring requirements.

2. Development and promulgation of Regulations which specify effluent limits which will be based on "best available technology, economically achievable" or water quality impacts, whichever is more stringent, and are aimed at reducing the loadings of persistent and toxic contaminants in municipal and industrial wastewater discharges.

3. Implementation of abatement programs and enforcement activities to ensure that specific objectives, program schedules and deadlines are met.

The MISA program will encompass at least 200 of Ontario's industrial establishments which discharge wastewaters directly into provincial waterways. These establishments are disaggregated into industrial sectors including:

- petroleum refining;
- organic chemicals;
- pulp and paper;
- iron and steel;
- metal mining and refining;
- industrial minerals;
- electric power generation;
- inorganic chemicals;
- metal casting.

All industrial dischargers and sectors not listed will be regulated under the MISA program eventually. Regulations for the sectors listed above are being developed at this time because their impacts on receiving waters is best known.

1.2 Monitoring Regulations for Ontario's Petroleum Refineries

The first monitoring regulation under the MISA program applies to all seven Ontario petroleum refineries. The refineries and their locations are as follows:

- Esso Petroleum Canada (Sarnia)
- Petro-Canada Inc. (Clarkson)
- Petro-Canada Inc. (Trafalgar)
- Petrosar Limited (Corunna)
- Shell Canada Products Limited (Sarnia)
- Suncor Inc. (Sarnia)
- Texaco Canada Inc. (Nanticoke)

The physical configurations the effluent treatment and outlet systems of these refineries are depicted in the Report on the 1986 Industrial Direct Discharges in Ontario (Ontario Ministry of the Environment, 1987: pp. 25-33). Data on conventional contaminant discharges from each refinery are also presented in that report. A description of the petroleum industry in Canada and Ontario is presented in the Economic and Financial Profile of the Ontario Petroleum Refinery Industry - Summary Report (Ontario Ministry of the Environment, 1988).

The petroleum refinery monitoring requirements are specified in two regulations:

1. "Effluent Monitoring - General" - a regulation which specifies flow measurement, sampling, toxicity testing, analytical and reporting requirements that will be common for all industrial sectors subject to the MISA program; and

2. "Effluent Monitoring - Petroleum Refining Sector" - a regulation that will define monitoring requirements specific to Ontario Petroleum Refineries.

These regulations will come into force six months after they are promulgated and continue in force during the subsequent 12-month period. At the end of the 18-month period, provisions of the "Effluent Monitoring - Petroleum Refining Sector" regulation will be terminated. Daily sampling, analyses and characterization requirements will continue after the 18-month period of the regulation. Other monitoring requirements that are to be implemented after the 18-month tenure of the "Effluent

Monitoring - Petroleum Refining Sector" regulation will be specified in an "effluent limits compliance regulation" which is expected to be promulgated in 1990.

1.3 Purpose of the Present Report

This investigation is part of the total economic assessment component of the MISA program which is discussed in the report, "Economic Information Needs and Assessments for Developing MISA Monitoring and Abatement Requirements" (Ontario, March 1987).

The intent of this report is to present estimates of the magnitudes of the incremental costs on the petroleum industry of the requirements in the effluent Monitoring Regulations for the Petroleum Refinery sector.

It would have been ideal to identify all feasible monitoring technologies or systems that could be applied to achieve the monitoring requirements and then determine which option would be least-cost to the refineries. Moreover, if the beneficial consequences of each potential monitoring technology or combination of monitoring technologies and procedures could be quantified, valued and compared, an optimum mix of monitoring systems could be determined.

Monitoring techniques and the types of equipment to be used were largely determined in negotiations with the industry during the Joint Technical Committee consultative process. By the time the present analysis was initiated, most of the various monitoring requirements had been decided upon.

Consequently, a systematic, benefit-cost assessment or a comprehensive cost-effectiveness analysis of the monitoring regulation is not presented in this report. However, the costs of the monitoring functions that have been estimated are deemed to be the most cost effective for each individual refinery. Finally, financial data were available to determine economic impacts of the monitoring costs on five out of six petroleum firms which operate refineries in Ontario.

1.4 Cost Estimation Methodology

There are two types of incremental costs of monitoring:

- one-time capital expenditures for equipment, installation, computers, software and vehicles;

- recurring (annual) operating expenses.

Capital and operating costs have been estimated for each monitoring function at each refinery.

The steps involved in cost estimation include:

- determination of the tasks, equipment, services and person-days and other factor inputs required to implement each monitoring function;

- specification of simplifying assumptions where there is insufficient information or where there are uncertainties about quantities of factor inputs required for a specific task.

To the extent possible, a range of cost estimates has been generated for each of the various monitoring functions for the following reasons:

- The actual equipment and labour and the prices of the various inputs required to implement different types of monitoring functions are uncertain.

- There is some flexibility as to how each refinery may implement some of the monitoring requirements (e.g., sampling) which may result in different costs.

- Single valued "point" estimates imply a degree of certainty and accuracy that seldom exists.

After a review of an initial draft of this report, the petroleum companies submitted estimates of the costs of complying with the regulations at their refineries (E.J. Carter, February 7, 1988). Industry representatives also provided useful comments on the earlier draft of this report.

Cost estimates provided by the petroleum companies are based on the following assumptions and perspectives:

- Any monitoring expenses that were incurred as a voluntary response to federal and provincial monitoring guidelines and which are now mandatory under the MISA regulations should be attributed entirely to the regulations (N.B. All refineries conduct monitoring for wastewater treatment process control which are not included in these estimates).

- Monitoring will be carried out by the refineries on water intakes as well as effluent sampling points. This is not expressly required in the regulations but is deemed necessary in order to determine the net loadings contributed by a plant.

- Many existing flow measurement and sampling devices at refineries will have to be replaced in order to comply with the regulations.

For some monitoring functions, an estimating procedure or prices for equipment or services were employed which were different from those used by industry. This was done in order to make the estimates comparable from one refinery to another or to produce disaggregations that were not provided by all companies. In some cases, firms have indicated that they plan to install optional equipment in order to avoid higher annual operating costs in the future.

All cost estimates are expressed in 1986-87 dollars.

Indications of the economic impacts of the monitoring costs on individual firms were estimated in the following manner:

- The capital costs of monitoring at each refinery were compared with the lowest annual capital expenditure in the petroleum segment of each company's operations between 1981 and 1985. This calculation indicates what proportion of the firm's capital expenditure would have to have been diverted to monitoring in the "worst year" for capital expenditure.

- The operating costs are compared with the lowest annual after-tax earnings or profits for the petroleum products segment of each firm between 1981 and 1985.

Data were available to conduct these analyses on each firm except Polysar. Moreover, financial data for individual refineries in Ontario are not available. Therefore, the analyses show the impacts of estimated monitoring costs on the consolidated petroleum products business segments of each particular company.

1.5 Plan of Report

The next section describes the requirements set out by the generic and the industry-specific regulations and enumerates the input requirements needed for each monitoring function. Assumptions that have been made to facilitate cost estimation are also specified in Section 2.0.

The cost estimates are presented in Section 3.0. The reader may wish to skip Section 2.0 since there are cross-references to the relevant subsections in Section 3.0. A discussion of the financial impacts of these costs is included in Section 3.11.

Conclusions and recommendations are presented in Section 4.0.

2.0 MONITORING PROCEDURES AND REQUIREMENTS

2.1 Components and Functions of Monitoring

Monitoring consists of six functions and activities which each wastewater discharger must implement to various degrees and levels of effort.

1. Sampling;
2. Wastewater flow measurement;
3. Characterization analyses;
4. Routine analyses;
5. Toxicity or biological testing;
6. Reporting and administration.

Each refinery may adopt a different configuration of monitoring functions according to its individual needs and existing practices. Some refineries have already installed certain monitoring instruments.

Another cost component includes the time and effort expended by industry personnel in developing the regulations and in conducting assessments and evaluations.

The following sections provide explanations of the six types of monitoring functions and the pre-regulation development activities. Estimates of physical input requirements for each function are enumerated.

2.2 Sampling Requirements

Sampling is the process of taking samples of effluent or discharge water from a refinery outfall or other locations which can be analyzed as required by the regulation.

Five types of sampling points or effluent streams are defined in the regulation:

1. Process effluent
2. Once-through cooling water
3. Stormwater
4. Emergency overflow
5. Landfarm leachate

Industry representatives have stated that intake water will also be tested at each plant in order to determine net loadings. While this is not expressly required by the regulations, sampling and testing of intake water will be necessary to determine precisely how much of a contaminant the refinery is actually discharging. It is a voluntary option which all plants will implement to some degree.

Sampling protocols and specifications concerning allowable equipment, sample containers, container pre-treatment, preservation, etc., are defined in Section 4 of the "Effluent Monitoring - General" regulation.

A description of each type of effluent stream, the sampling methods that are permitted and the number of each type of sampling point that is located at each refinery are summarized in Table 2.1.

In addition, because the regulations restrict materials used in sampling devices to fluorocarbon resins, glass, stainless steel and various types of polyethylene plastics, many of the existing sampling devices in refineries will have to be replaced.

All sampling equipment and flow measurement devices must be installed with the necessary fittings to enable ready and safe access and inspection by a provincial officer.

Refrigeration equipment will be required at each refinery to keep samples at required temperatures while they are being taken and to store samples longer than 24 hours before analysis. In some situations and locations, explosion-proof equipment will be required. Moreover, if samplers are located outdoors, they must be housed in an insulated, heated enclosure to prevent freezing during the winter.

For purposes of this analysis, it is assumed that a new vehicle will be dedicated to the collection of samples at each refinery.

Because of the large number of samples that have to be prepared, laboratory preparation space will be enlarged at two of the refineries.

2.3 Flow Measurement

Effluent flows are measured as a volume per unit time (e.g., litres per day, cubic metres per month, etc.). Flow measurements are necessary in order to calculate contaminant loading in each effluent stream and from the refinery as a whole. The installation of automatic flow measurement devices at certain sampling points is required in order to achieve the required accuracy. Some firms intend to install flow measurement equipment at inlets to allow calculation of net loadings. Actual flow measurements can be made and recorded continuously with automatic equipment, or they can be recorded manually at the time of sampling by a technician.

Flow measurement requirements at each type of sampling point, together with the measurement techniques that can be used, are summarized in Table 2.2.

A primary flow measurement device is defined in the regulation as an apparatus which produces, at a specified sensing location or set of locations, a defined range of measurements that are uniquely related to the flow at that location. Primary flow measurement devices include hydraulic flumes or weirs for open channel flows, or meters, such as an orifice plate or a magnetic meter, for pressure pipe flows.

Once the flow has been channelled by the primary device, a secondary flow measurement device converts the information from a sensor or sensors installed on the primary device into flowrate data. The secondary device may have ancillary equipment to facilitate the visual display of flow rate and volumes passed. Analog or digital meters, integrators, recorders, data loggers and computers are components of secondary measurement devices.

The difficulty and expense of installing flow measurement devices varies from one plant to another due to site-specific characteristics such as the volume of effluent flow and the accessability of the sites to install the equipment. Some firms will have to excavate new man-holes to reach effluent pipes in order to install equipment. Others will only have to install weirs or flumes in an effluent ditch. Installation costs generally exceed equipment expenses.

TABLE 2.1
SAMPLING REQUIREMENTS FOR PETROLEUM REFINERY EFFLUENT MONITORING

Sampling Point Location	Description*	Location	# of Streams per Refinery**	Automatic Sampling		Manual Sampling			
				Flow Proportional Composite Sampler	Equal-Time, Equal-Volume Sampler	Min. of 8 Combined in Proportion to Flow	Min. of 8 at Equal Time, Equal Volume	3 Equal Vol. Grab Samples Over a 24-hr Period	1 Grab Sample
Process Effluent	Effluent from a plant which is contaminated or potentially contaminated due to contact by design with any process.	On a process effluent stream situated: a) before the place of discharge watersources, b) after final treatment, and c) upstream of any significant contaminant masking or significant dilution by any other effluent.	1. = 1 2. = 1 3. = 1 4. = 1 5. = 1 6. = 1 7. = 1	P	P (NP if flow is variable)	P	P (NP if flow is variable)	NP	NP
Once-through Cooling Water	Water that has been circulated once through heat transfer equipment.	On a once-through cooling water stream situated before the place of discharge to a surface watercourse.	1. = 3 2. = 2 3. = 0 4. = 0 5. = 2 6. = 1 7. = 0	P	P	P	P	P	NP
Stormwater Outfalls	Contaminated or potentially contaminated run-off from a storm event that: a) results from precipitation on the developed areas of a plant, and b) discharges to a surface watercourse through a sewer or ditch.	On a storm water stream situated before the place of discharge to a surface water-course.	1. = 1 2. = 1 3. = 0 4. = 1 5. = 1 6. = 0 7. = 1	P	P	P	P	P	NP
Emergency Overflow	A diversion of effluent which by-passes the designated sampling point for that effluent.	On an emergency overflow stream situated: a) before the place of discharge to a surface watercourse, and b) upstream of any significant contaminant masking or dilution by other effluent.	1. = 3 2. = 0 3. = 1 4. = 0 5. = 1 6. = 0 7. = 0	P	P	P	P	N/A	P
Landfarm Leachate	Any liquid that percolates through or runs off a waste disposal site and is collected.	For discharge or it is discharged to a surface watercourse. Also called "waste disposal site effluent".	1. = 0 2. = 0 3. = 0 4. = 1 5. = 0 6. = 1 7. = 0	P	P	P	P	N/A	P

* See Section 1, "Definitions", in "Effluent Monitoring - General" Regulation

** 1. Esso (Sarnia)
2. Petro-Canada (Clarkson)
3. Petro-Canada (Trafalgar)
4. Petrosar (Corunna)
5. Shell (Sarnia)
6. Suncor (Sarnia)
7. Texaco (Nanticoke)

P = Sampling Technique Permitted
NP = Sampling Technique Not Permitted
N/A = Not Applicable

TABLE 2.2

REQUIREMENTS FOR FLOW MEASUREMENT UNDER THE PETROLEUM REFINERY EFFLUENT MONITORING REGULATION

Outfall Type	Flow Measurement Requirements	Accuracy	Flow Measurement Options Permitted
Process	Continuous flow Measurement	+/-5% on primary +/-2% full scale on secondary	Primary and Secondary devices; custom methods
Once-through Cooling water	Measurement at time of sampling	+/-20% of actual flow	Primary device; Pumping rates; Water balance
Stormwater	Measurement at time of sampling	+/-20% of actual flow	Primary device; friction formula
Emergency Overflow	Record of event date and approximate duration of discharge	N/A	Visually observe or event logger
Landfarm Leachate	Volume/duration of each discharge event	+/-20% of actual volume	Pond drawdown; Other non-continuous methods

N/A = Not Applicable

Source: Ontario, Ministry of the Environment, Petroleum Refining Sector Monitoring Regulation.
Fritz Engler, Water Resources Branch, 1987

TABLE 2.3

SUMMARY OF EXISTING FLOW MEASUREMENT DEVICES AT EACH REFINERY

Refinery	Effluent Type	Primary Flow Monitoring Device	Secondary Flow Monitoring Device
1. Esso (Sarnia)	P	have	required
	C1 - C3	do not have	do not have
	S	n/r	n/r
	E	n/r	n/r
	L	n/r	n/r
2. Petro-Canada (Clarkson)	P	have	have
	C	have	have
	S	n/r	n/r
	E	have (keep)	have (keep)
	L	n/r	n/r
3. Petro-Canada (Trafalgar)	P	have	have
	C	n/r	n/r
	S	n/r	n/r
	E	do not have	do not have
	L	n/r	n/r
4. Petrosar (Corunna)	P	have	have
	C	n/r	n/r
	S	do not have	do not have
	E	n/r	n/r
	L	have (calibrated pond)	do not have
5. Shell (Sarnia)	P	have	have
	C1 - C2	do not have	do not have
	S	n/r	n/r
	E	do not have	do not have
	L	n/r	n/r
6. Suncor (Sarnia)	P	have	have
	C	have	do not have
	S	n/r	n/r
	E	n/r	n/r
	L	have (pond)	do not have
7. Texaco (Nanticoke)	P	have	have
	C	n/r	n/r
	S	have	have
	E	n/r	n/r
	L	n/r	n/r

P = Process Effluent
C = Once-through Cooling Water
S = Stormwater
E = Emergency Overflow
L = Landfarm Leachate
n/r = Automatic primary and secondary flow measuring equipment not required.

Sources: Ontario, Ministry of the Environment, Water Resources Branch, Refinery Summary, March 11, 1987.

Fritz Engler, Water Resources Branch, Personal Communication, July 3, 1987.

Table 2.3 identifies the flow monitoring devices which were in place at each of the refineries in March 1987.

Automatic primary and secondary flow measurement devices are required for process flows to meet accuracy requirements specified in Table 2.2. In some cases, it may be possible to obtain flow measurements in the MISA accuracy requirements by methods other than automated primary and secondary devices. The choice of a method depends on the site characteristics and the nature of the costs of the methods. One-time capital expenditures are preferred to recurring annual operating costs in perpetuity.

The regulation also requires that fittings be installed on process water outfall flow measurement primary devices which permit callibration of these devices. For devices already installed, this requirement could be met by dismantling the flow measurement device or by reinstalling new equipment.

Monitoring of inlet or intake water is not explicitly required by the regulations. However, those refineries which take their process and cooling water from water bodies which have municipal and industrial wastes discharged into them have an incentive to monitor their intake water in order to determine their net loadings to watercourses.

Flow measurement devices must also be safely accessible to provincial officers. This requirement could necessitate significant structural improvements and costs.

2.4 Characterization Analyses

All samples are assumed to be sent to a commercial laboratory for characterization or routine analyses. Characterization analysis requirements are specified in Section 4 of the "Effluent Monitoring - Petroleum Refining Sector" regulation. The parameters to be analyzed are listed as the analytical test groups in Schedule A of the aforementioned regulation.

Analytical test groups consist of those contaminants which can be detected and measured by a similar type of test. There are 27 analyzed test groups listed in Schedule A which include about 150 individual chemicals.

Prices of tests include quality assurance/quality control (QA/QC) samples and the preparation of required reports. In some cases, a price for an analysis includes transporting samples. Prices for sample analyses used in this study are based on a survey of seven Ontario laboratories (MOE, 1988). No attempt was made to estimate the costs of building laboratory facilities on site as an alternative means of completing the analyses.

Characterization analyses must be conducted twice within the first year and once every three years thereafter and after each significant process change. Samples for characterization analyses must be taken from all process effluent streams after final treatment but prior to dilution with once-through cooling water.

2.5 Routine Analyses

Whereas characterization analyses are conducted once or twice per year and involve tests for a large number of contaminants, routine analyses involve more frequent tests but for fewer numbers of contaminants.

Routine analyses for specified contaminants are carried out on samples from designated outfalls on a daily, thrice-weekly, monthly, quarterly, annual, or "event" basis. The analyses required depends upon the effluent type and the expected contaminants in the effluent. Frequencies of routine analyses are specified in Schedule A of the "Effluent Monitoring - Petroleum Refining Sector" regulation. The analytical test groups to be analyzed and their required frequencies are summarized in Table 2.4. The numbers listed in the columns in Table 2.4 refer to analytical test groups noted in Table 3.3.

2.6 Toxicity Testing

Toxicity or biological testing is conducted by using the static 96-hour LC50 toxicity test. A series of graded water/wastewater concentration samples are used to determine the concentration of effluent that is lethal to 50% of a pre-specified number of aquatic organisms, such as rainbow trout fingerlings, over a 96 hour period. This concentration of effluent is known as the "LC50 concentration". This test is to be conducted

TABLE 2.4

FREQUENCIES OF ROUTINE ANALYSES AND ANALYTICAL TEST GROUPS** TO BE ANALYSED

Sampling Points/ Effluent Streams	Daily	3 x Weekly	Monthly	Quarterly	A Time of Discharge	Yearly
Process Effluent Streams	Col. 4* 3,8,14	Col. 5* 3,4a(NH_4), 5,6,8,14, 15,17,25	Col. 5* 3,4a(NH_4), 5,6,8,14, 15,17,25	Col. 6* 1-20, 25		
Once-through Cooling Water Streams			Col. 8* 3,5,8,9,** 14,15,17, 25			
Stormwater Effluent					Col. 5* 3,4a(NH_4), 5,6,8,14, 15,17,25	
Emergency Overflow					Col. 5* 3,4a(NH_4), 5,6,8,14, 15,17,25	
Landfarm Leachate					Col. 5* 3,4a(NH_4), 5,6,8,14, 15,17,25	Col. 6* 1-20, 25

* Refers to columns in Schedule A of the "Effluent Monitoring - Petroleum Refining Sector" regulation.

** Numbers in columns refer to analytical test groups listed in Table 3.3.

monthly at all process effluent sampling points, and quarterly at all once-through cooling water sampling points.

Two toxicity test protocols are required. One uses rainbow trout fingerlings while the other employs Daphnia magna, a small invertebrate crustacean.

Table 2.5 presents the number of toxicity tests of each type required annually at each refinery.

2.7 Reporting and Administration

Monitoring data will have to be assembled, recorded, stored, and reported to company management and the Ministry of the Environment. Data storage and manipulation will require an AT personal computer together with compatible peripherals and software.

Industry sources estimate that reporting and administration will require one full person-year at the middle management/engineering level to initiate and carry out the monitoring program in a regulatory framework.

Personnel requirements are expected to drop to .25 person-years during subsequent years.

2.8 Pre-Regulation Consultation and Meetings

Personnel from the petroleum industry spent time at meetings and review committees in order to participate in the development of the regulations.

Between April 1986, when the Petroleum Sector Joint Technical Committee (JTC) was initiated, and the end of December, 1987, industry representatives spent approximately 160 person days in meetings and committees.

In addition, the petroleum companies report that the following number of person-days were spent over 12-months to undertake pre-regulation monitoring tasks (H.J. Carter, 1988):

Esso Petroleum	60 person-days
Petro-Canada - Clarkson	72 person-days
- Trafalgar	72 person-days
Petrosar	50 person-days
Shell Canada Products	48 person-days

TABLE 2.5

NUMBER OF RAINBOW TROUT AND DAPHNIA MAGNA TOXICITY TESTS REQUIRED FOR EACH REFINERY

Refinery	No. of Process Effluent Streams (12 x)	No. of Cooling Water Outlets (4 x)	No. of Each Type of Test per Year
1. Esso (Sarnia)	1 = 12	3 = 12	24
2. Petro-Canada (Clarkson)	1 = 12	2 = 8	20
3. Petro-Canada (Trafalgar)	1 = 12	Ø	12
4. Petrosar (Corunna)	1 = 12	Ø	12
5. Shell (Sarnia)	1 = 12	2 = 8	20
6. Suncor Inc. (Sarnia)	1 = 12	1 = 4	16
7. Texaco (Nanticoke)	1 = 12	Ø	12

Sources: Ontario, Ministry of the Environment, "Effluent Monitoring - Petroleum Refining Sector";

Wendy Moss, Water Resources Branch, Personal Communications, 1987.

Suncor	125 person-days
Texaco Canada	72 person-days
Subtotal	499 person-days
JTC Meetings etc.	160 person-days
TOTAL	659 person-days

These estimates may understate the amount of staff time actually spent on pre-regulation assessments and they do not necessarily represent the time requirements of staff in the future.

2.9 Recommendations of the MISA Advisory Committee (MAC)

The MISA Advisory Committee is a group of experts which was established to provide the MISA process with an independent, third party opinion. This Committee reviewed the draft Refinery Regulation and issued a report on June 17, 1987 which contained several recommendations concerning additional tests or modifications of those specified in the regulations.

The Ministry responded to these recommendations in the Draft Effluent Monitoring Regulation for the Petroleum Refining Sector (July 1987). One of the MAC recommendations, that acute toxicity tests using Daphnia magna be required, has been included in the regulations.

3.0 MONITORING COST ESTIMATES

3.1 Comprehensiveness and Accuracy

Expected incremental capital and operating costs are estimated for each monitoring function and for certain activities that were completed during the development of the regulations. Uncertainties are due primarily to lack of information about the physical input requirements for each monitoring function. As discussed, estimates of the monitoring installations and their associated costs have been provided by the individual companies.

Data sources, assumptions and other factors that account for the potential range of estimates for certain monitoring functions are explained. Industry representatives stated that the capital cost estimates they supplied could vary by +/- 30%.

3.2 Timing

Costs will be incurred during the 18-month tenure of the regulation. Subsequent to this period, the frequency and number of routine analyses required may be changed if the results indicate that some contaminants are not present in the wastewater streams. Other monitoring functions, including toxicity testing, flow measurement, sampling and reporting may also be changed. However, sampling and analysis of process water effluents will continue.

Equipment and structures that are purchased and installed for flow measurement, sampling and reporting will be serviceable for the next five to ten years. At a minimum, companies may be able to write off their capital expenditures over three years for tax purposes. If the companies continue to use the monitoring equipment after the regulation has expired, it would be appropriate to "annualize" the capital expenditures over the relevant time period using an agreed-to interest rate. For purposes of this exercise, it is assumed that the equipment will be used for at least 5 years after installation. Capital costs will, therefore, be "annualized" over a 5-year period in order to provide an indication of the total cost over the duration of the regulation.

3.3 Sampling Facilities

The regulations require that samples be collected on a daily basis. Each refinery will likely have to dedicate a vehicle for this purpose. A new van will cost about $18,000 to buy or $6,000 per year to lease. Assuming the vehicle travels 10,000 km per year and using a government reimbursement rate of $.275 per km, the annual operating costs would amount to $2,750 at each refinery. If the truck is leased, the annual cost would be $8,750.

The regulations require that samples must be collected and stored until analyzed, in an environment that is cooled to below 10°C and prevented from freezing. Consequently, at a minimum, refrigeration equipment is required at each refinery to store samples. These units would have to be explosion-proof at some refineries. Industry spokesmen report that refrigeration equipment to house automatic samplers would cost $6,500 while explosion-proof refrigerators to store samples prior to analysis could cost as much as $2,500.

Engler (1987) estimated that it would take employees at each refinery about 25 to 30 hours per week to collect samples. In a report to the Ontario Petroleum Association, Maynard and Young (February 1987) estimated that all sampling and some analytical activities would require about 84.5 hours of staff time per week at each refinery. However, after time associated with analyses is deducted, sampling alone would appear to involve 30.5 hours per week of staff time, a confirmation of Engler's estimate.

Maynard and Young (February 1987: Section 8) also note that two technicians and two scientists would be required for sampling at salaries of $30,000 and $45,000 per year respectively. These wage rates represent $16 and $23 per hour. Since it is not known just what mix of staff will be used in collecting samples, an average of $19 per hour is used as the wage rate for the sampling activity at each refinery together with the 30 hours per week of sample collection activity.

Automatic, flow-proportional samplers cost between $7,000 and $10,000. However, installation costs, which include temperature recorders, electrical supply, signal cables and construction, are sensitive to site-specific circumstances.

Industry OPA estimates of capital (which include equipment and installation) and operating costs for sampling are shown in Table 3.1. Summary cost estimates for this function were derived in the following manner:

- Capital cost estimates show what is being spent on inlet samplers and what is being spent for samplers on effluent streams that are specifically required by the regulations.

- An amount of $30,000 per year in operating and maintenance is assumed for refineries lacking a specific estimate from the OPA.

- Transportation costs for collecting samples are estimated to be $8,750 per year at each refinery.

Construction of additional laboratory space for sample preparation has been budgeted by two of the seven refineries.

Table 3.1 shows that the capital costs for sampling total $506,000. The intake water sampling facilities costs a total of $135,000 while sampling devices at outlets as required by the regulation could entail capital expenditures of $371,000. Because the capital cost estimates could vary by +/- 30%, the total capital costs for this function could range between $354,000 and $657,800.

Operating costs are likely to total $287,250 for all seven refineries.

If a refinery opted for a manual sampling system, two people would be required for grab sampling for safety. If actual collection takes about 30 minutes per location, daily sampling would entail 4 hours per day, 365 days per year.

However, union contract requirements and other practicalities would necessitate the employment of two 2-person crews over two shifts. According to industry sources, it is also unlikely that these crews would be able to be usefully employed at anything else. Consequently, the total number of person hours per day devoted to this activity could be a much as 32 person hours per day or 11,680 person hours per year.

TABLE 3.1

AUTOMATIC SAMPLING FACILITIES COST ESTIMATES

Cost Items	Esso (Sarnia)	Petro-Canada (Clarkson)	Petro-Canada (Trafalgar)	Petrosar (Corunna)	Shell (Sarnia)	Suncor (Sarnia)	Texaco (Nanticoke)	TOTALS
Capital								
Equipment & Installation*	90,000	22,000	20,000	20,000	40,000	100,000	24,000	316,000
Buildings*	0	0	0	0	50,000	140,000	0	190,000
Subtotal	$90,000	$22,000	$20,000	$20,000	$90,000	$240,000	$24,000	$506,000
Equip. & Install. for Inlet water	45,000	22,000	10,000	0	8,000	50,000	0	$135,000
Capital Equip. & Install. for Process Water	$45,000	$0	$10,000	$20,000	$82,000	$190,000	$24,000	$371,000
Operating Costs								
Operation and Maintenance*	30,000**	48,000	48,000	30,000	39,000	14,000	11,000	$220,000
Vehicle Leasing & Operation***	8,750	8,750	8,750	8,750	8,750	8,750	8,750	$ 61,250
Subtotal	$38,750	$56,750	$56,750	$38,750	$47,750	$22,750	$19,750	$281,250

* Source: H.J. Carter, OPA, February 1988.
** MOE estimate, Esso stated $0 operating and maintenance.
*** See text for explanation.

The annual cost for manual sampling would, therefore, amount to:

> 32 person hours/day x 365 days x $19/person hour = $221,920 per year per refinery

The difference in annual expenditures for sampling between the use of automatic samplers and manual sampling could be as much as $1.3 million per year for all seven refineries.

Under these conditions, automatic sampler are clearly the lower cost option.

3.4 Flow Measurement

Site visits by MOE personnel in March 1987 found that each of the refineries already had some type of primary flow measurement device on its process effluent outfalls (see Table 2.3). Industrial representatives have subsequently determined that flow measurement facilities identified in Table 2.3 will not satisfy MISA requirements. They note that virtually all of the monitoring points in each refinery will require new flow measurement equipment.

Estimates of the capital (equipment and installation) costs of flow measurement facilities have been provided by each of the seven refineries together with maintenance costs. The estimates summarized in Table 3.2 show:

(a) The costs of upgrading or replacing flow measurement equipment at process water sampling points.

(b) The cost of primary and secondary devices on intake water.

(c) The cost of devices at cooling and storm water sampling points.

(d) The total cost estimates provided by industry.

Operation and maintenance costs are provided by the industry. Two of the refineries do not expect to incur any additional maintenance costs.

As shown in Table 3.2 a total of $73,700 in capital expenses is allocated for flow measurement of

TABLE 3.2

FLOW MEASUREMENT COST ESTIMATES

Cost Items	Esso (Sarnia)	Petro-Canada (Clarkson)	Petro-Canada (Trafalgar)	Petrosar (Corunna)	Shell (Sarnia)	Suncor (Sarnia)	Texaco (Nanticoke)	TOTALS
CAPITAL COSTS								
Cost of devices at process sampling points	35,000	29,000	10,000	20,000	32,000	80,000	0	$206,000
Cost of devices at intake water	41,700	0	0	0	32,000	0	0	$ 73,700
Cost of devices at cooling and stormwater sampling points	83,300	0	0	160,000	96,000	80,000	13,000	$432,300
TOTAL*	160,000	29,000	10,000	180,000	160,000	160,000	13,000	$712,000
OPERATING COSTS*	0	19,000	4,000	0	16,000	16,000	3,000	$ 58,000

* Source: H.J. Carter, February 1988.

intake water which is not explicity required by the regulation. A total of $206,000 is budgetted for upgrading or replacing devices on process water outfalls. According to Table 2.3, only Esso did not have a secondary flow measurement device on its process water outfall for which it intends to spend $35,000.

Five of the refineries intend to spend $432,300 on measurement devices at once-through cooling and storm water sampling points. Petrosar reports that the expenditure of $160,000 is necessary in order to install devices that will permit a determination of flows within the +/-20% accuracy requirement of the regulation.

Given a +/-30% uncertainty level, the total capital costs could, therefore, range from $498,400 to $925,600 with a point estimate of $712,000.

The firms also report that they intend to install primary and secondary devices on these outflows in order to obtain data that will permit a more accurate estimate of the discharge volumes than required by the regulations and which will facilitate more accurate estimates of contaminant loadings than would otherwise be possible. It was reported that while the equipment cost of flow measurement and recording devices to achieve a 2%-3% accuracy would be significantly higher than devices to achieve an accuracy of +/-20%, the final installed cost would be very similar.

The industry expects that operation of flow measurement devices will cost a total of $58,000 per year.

3.5 Characterization Analyses

For purposes of these estimates, it is assumed that all characterization and routine analyses will be performed by a commercial laboratory. Because laboratory capacity is available in Sarnia and other communities near Ontario refineries, sample transport costs are assumed to be included in the test prices.

Use of analyzers for certain chemicals is severely limited by the regulation. These devices may be considered for future adoption, however.

Commercial laboratory prices for each test group are listed in Table 3.3 and are based on a survey

TABLE 3.3

AVERAGE ONTARIO COMMERCIAL LABORATORY PRICES FOR ANALYTICAL TEST GROUPS

No.	Analytical Test Group	Average Price $
1	Chemical Oxygen Demand	30.58
2	Cyanide	37.07
3	Hydrogen ion (pH)	5.57
4a	Ammonia Nitrogen plus Ammonium $18.50) Total Kjeldahl Nitrogen 30.83)	49.33
4b	Nitrate $18.17) Nitrite 16.50)	34.67
5	Dissolved Organic Carbon (DOC)	30.00
	Total Organic Carbon	31.25
6	Total Phosphorus	22.50
7	Specific Conductance	7.50
8	Total Suspended Solids (TSS)) Volatile Suspended Solids (VSS))	14.50
9	Total Metals (13 metals)	108.21
10	Hydrides (antimony, arsenic, selenium)	21.83
11	Chromium (Hexavalent)	21.64
12	Mercury	19.17
13	Total Alkyl Lead	145.00
14	Phenolics (4AAP)	36.83
15	Sulphide	30.00
16 17 18	Volatiles, Halogenated) Volatiles, Non-Halogenated) Volatiles, Water Soluble)	250.00
19 20	Extractables, Base Neutral) Extractables, Acid (Phenolics))	400.00
21	Extractables, Phenoxy Acid Herbicides*	N/A
22	Extractables, Organochlorine Pesticides*	N/A
23	Extractables, Neutral-chlorinated	213.57
24	Chlorinated Dibenzo-p-dioxins and Dibenzofurans	1,187.50
25	Solvent Extractables (Oil and Grease)	38.36
26	Fatty and Resin Acids	125.00
27	PCB's (Total)	123.29
	Gas Chromatography and Mass Spectrometry Open Scans	500.00

N/A = Not Available
* = Does not apply to the Petroleum Refining Sector
Source: Ontario, Ministry of the Environment. Inventory and Critical Review of Laboratory Resources, Toronto. Laboratory Services Branch, Ontario Ministry of the Environment, 1988.

of seven Ontario commercial laboratories (Ontario Ministry of the Environment, 1988). Note that the test groups listed in Table 3.3 are the same ones referred to in Table 2.2. Based on the price list shown in Table 3.3, a complete characterization analysis could cost about $3,000.

The regulations stipulate that each refinery will have to conduct two characterization analyses on its process effluent sampling point during the term of the regulation. At $3,000 per characterization analysis series, the cost could be as much as $6,000 per refinery during the first year.

Refineries may not have to incur this total cost because they will be permitted to use results from the routine analyses in their characterization report. If this were done, the total cost of a characterization for those parameters not included in any of the routine analyses could be as low as $1,350 or about $2,700 per year per refinery. Using this figure, characterization would cost a total of about $18,900 for all seven refineries during the period of the regulation.

The refineries report that pre-program characterization analyses plus analyses during the duration of the regulation will cost a total of $225,000. About $143,000 or 64% of this amount appears to have already been spent on studies during pre-program consultations. Of the remainder, some refineries plan to carry out characterization analyses on inlet waters which are not required in the regulations but which will provide useful data.

Consequently, characterization analyses during the period of the regulation would cost between $2,700 and $6,000 per refinery or $18,900 to $42,000 per year for all seven establishments.

3.6 Routine Analyses

The number of routine analyses, hence costs, will vary from one refinery to another because each refinery has a different configuration of monitoring points as shown in Table 2.1.

Using the price list in Table 3.3, estimates of the annual cost of routine analyses amount to between $124,960 and $156,402 per refinery for a total of $974,015. As noted, transport costs are assumed to be included in these prices. Furthermore, because

the regulation will be in force only 18 months, it is assumed that no capital costs need be incurred strictly to comply with this aspect of the regulating.

However, the OPA reports that the refineries intend to spend about $315,000 in capital improvements for both routine analyses and toxicity tests. Furthermore, the annual laboratory costs of routine analyses were estimated by the companies to be $1,043,000 over the 12-month period when testing would take place. OPA estimates are reported to be based on commercial laboratory price lists or in-house costs.

Because the regulation will be in force only during an 18 month period, it is possible that routine analysis could be implemented without capital improvements to in-house laboratories. However, two companies report that they will each purchase new gas chromatograph analyzers and 5 refineries plan to purchase extra glassware for their laboratories. These extra capital expenditures total $315,000 for this function.

Given the uncertainties inherent in the estimates and the potential for lower test prices for large volume contracts, the operating cost range of $944,015 to $1,043,000 appears entirely plausible.

Table 3.4, which summarizes capital cost estimates, includes proposed capital costs for capital improvements for routine analyses in the OPA total costs.

Two factors could contribute to higher costs than those identified for characterization and routine analyses. First, transport costs from the refineries to the commercial laboratories have not been estimated. These costs could amount to as much as $50.00 per shipment depending on the distance from the lab to the refinery. Second, to the extent that the demand for laboratory tests and other services increase more rapidly than lab capacity, prices for various tests would increase faster than the rate of inflation.

3.7 Toxicity Testing

Commercial lab prices for the trout and daphnia toxicity tests range as follows:

- trout: $300-$600 per test
- daphnia: $200-$500 per test

Prices obtained from commercial laboratories by Ministry staff averaged $380 per trout test and $250 per daphnia test. These prices are used in the estimates. The numbers of each type of toxicity test mandated for each refinery by the regulation were summarized in Table 2.5.

Using the average commercial laboratory prices and the testing schedule specified in Table 2.5, the total cost of this function during a 12-month period amounts to $72,840. Higher estimates of toxicity costs were submitted by some refineries than are shown in Table 3.5 because they intend to conduct more tests than required by the regulation (e.g., 60 tests versus 40 at the Petro-Canada, Clarkson refinery; 56 instead of 40 at Shell).

3.8 Reporting, Administration and Contingencies

Firms will require an AT personal computer, software and personnel dedicated to perform the data storage and report generation functions. Consequently, the oil companies estimated that $42,000 in capital costs would have to be expected for reporting.

The oil companies estimate that operating costs for reporting and administration could range from $14,000 to $20,000 per refinery. The actual set up costs at the outset of the regulation period could be higher for some refineries because a systems engineer may be required in debugging the system.

Part of these costs may be included in a miscellaneous/contingencies cost category cited by each company that ranged from $46,000 to $83,000 per refinery, for a total of $405,000 for all seven. These and other operating cost estimates are summarized in Table 3.5.

3.9 Regulation Development

Based on an estimated 660 person-days spent on pre-regulation meetings and committees and using a gross value of $350/day for salary and overhead, the costs of pre-regulation labour by industry amounts to $231,000.

As noted, these estimates do not include time spent after December 31, 1987.

TABLE 3.4

SUMMARY OF CAPITAL COST ESTIMATES FOR EACH REFINERY

Monitoring Activity	Esso (Sarnia)	Petro-Can (Clarkson)	Petro-Can (Trafalgar)	Petrosar (Corunna)	Shell (Sarnia)	Suncor (Sarnia)	Texaco (Nanticoke)	TOTAL FOR ALL REFINERIES
Sampling, Total*	90,000	22,000	20,000	20,000	90,000	240,000	24,000	$ 506,000
Capital for Intake Water	45,000	22,000	10,000	0	8,000	50,000	0	$ 135,000
Flow Measurement, Total*	160,000	29,000	10,000	180,000	160,000	160,000	13,000	$ 712,000
Capital for intake water	41,700	0	0	0	32,000	0	0	$ 73,700
Capital for storm and cooling water sampling points	83,300	0	0	160,000	96,000	80,000	13,000	$ 432,300
Characterization Analyses	0	0	0	0	0	0	0	0
Routine Analyses	130,000	6,000	29,000	0	30,000	120,000	0	$ 315,000
Toxicity Testing	0	0	0	0	0	0	0	0
Reporting	4,000	0	11,000	12,000	15,000	0	0	$ 42,000
Total Capital Cost per Refinery								
Point Estimate	$384,000	$57,000	$70,000	$212,000	$295,000	$520,000	$37,000	$1,575,000
Potential Range (+/- 30%)	$268,800 - $500,000	$40,000 - $74,100	$49,000 - $91,000	$148,400 - $275,600	$206,500 - $383,500	$364,000 - $676,000	$26,000 - $48,000	$1,102,500- $2,047,500
Annualized Cost (at 10% over 5 years)								
Point Estimate	62,900	9,340	11,470	34,725	48,320	85,175	6,060	$ 257,980

* Source: H.J. Carter, OPA, February 1988.

3.10 Total Costs of the MISA Petroleum Refining Sector Monitoring Requirements

The total capital and operating costs that could be incurred to comply with the regulations are discussed in this section along with the potential impacts on the refineries.

Table 3.4 presents a summary of the capital cost estimates for each monitoring function. The point estimate of the total capital costs is $1,575,000. Because of the uncertainties associated with these estimates, the actual total capital expenditures could vary by +/-30% or between $1 million and $2 million. About $208,700 or 13% of the point estimate would be used for the installation of sampling and flow measurement equipment on intake water points.

Spokesmen for the refineries have emphasized that they intend to install automatic samplers and flow measurement facilities at virtually all of their sampling points and intake water in order to reduce long term, recurring labour costs that are associated with other methods of sampling and flow measurement.

The refineries have stated that they intend to invest more capital than may be strictly required by the regulation in order to obtain data about intake water and to reduce long-term personnel requirements for monitoring functions by substituting capital equipment for labour.

Table 3.5 shows the estimated costs for characterization, routine and toxicity analyses for each refinery using a common estimating procedure. The total operating costs of all functions, including contingencies and intake water testing, could amount to about $2 million. Oil firms indicate that these estimates could be off by +/-15%. At this level of uncertainty, operating expenditures could range as high $2.3 million. Of this amount, $145,168 would be required for characterization, routine and toxicity analyses for intake water.

The total capital and operating cost point estimate (including intake water testing and contingencies) would amount to $3.7 million. However, if the refineries continue to use the capital equipment after the monitoring regulations have expired, the capital costs should be "annualized" to reflect the fact that the equipment will last longer than one

TABLE 3.5

SUMMARY OF MISA PETROLEUM REFINERY MONITORING COSTS - POINT ESTIMATES

MONITORING ACTIVITIES	ESSO	PETROCAN Clarkson	PETROCAN Trafalgar	PETROSAR	SHELL	SUNCOR	TEXACO	TOTALS $	TOTALS %
Characterization Analyses									
Process Sampling Points	$2,700	$2,700	$2,700	$2,700	$2,700	$2,700	$2,700	$18,900	0.91
Intake water	2,700	2,700	2,700	2,700	2,700	2,700	2,700	18,900	
Routine Analyses									
daily	20,769	20,769	20,769	20,769	20,769	20,769	20,769	145,383	
3xweekly	88,268	105,149	105,149	105,149	105,149	88,268	88,268	685,400	
monthly									
cooling water	2,049	1,366	0	0	1,366	683	0	5,464	
storm & leachate	5,480	5,480	0	10,960	5,480	5,480	5,480	38,360	
quarterly	10,440	9,141	9,141	9,141	9,141	10,440	10,440	67,884	
yearly (leachate)	0	0	0	762	0	762	0	1,524	
misc. maintenance	0	0	0	0	0	30,000	0	30,000	
Sub-total (process, cooling etc. sampling points)	127,006	141,905	135,059	146,781	141,905	156,402	124,957	974,015	46.80
Intake water	12,489	10,507	9,141	9,141	10,507	11,123	10,440	73,348	
Toxicity testing									
Trout	9,120	7,600	4,560	4,560	7,600	6,680	4,560	44,680	
Daphnia	6,000	5,000	3,000	3,000	5,000	4,000	3,000	29,000	
Sub-total (process, cooling etc. sampling points)	15,120	12,600	7,560	7,560	12,600	10,680	7,560	73,680	3.54
Intake water	7,560	7,560	7,560	7,560	7,560	7,560	7,560	52,920	
Flow measurement*	0	19,000	4,000	0	16,000	16,000	3,000	58,000	2.79
Sampling (maint. & vehic.)	38,750	56,750	62,750	38,750	47,750	22,750	18,750	286,250	13.76
Reporting and Admin.*	20,000	19,000	19,000	16,000	16,000	16,000	14,000	120,000	5.77
Misc./Contingencies*	59,000	54,000	51,000	46,000	58,000	83,000	54,000	405,000	19.46
TOTAL OPERATING COSTS									
Total Intake Water Testing	22,749	20,767	19,401	19,401	20,767	21,383	20,700	145,168	6.98
Total without Contingencies & Intake Water	$203,576	$251,955	$231,069	$211,791	$236,955	$224,532	$170,967	$1,530,845	
Total with Contingencies & Intake Water	285,325	326,722	301,470	277,192	315,722	328,915	245,667	2,081,013	100.00

* Source: H. J. Carter, Ontario Petroleum Association, Feb. 1988

year. The annualized point estimate for all capital items, over 5 years at 10%, would amount to $257,980 per year. If this figure is used, then the point estimate operating cost of the regulation would total $2.3 million for the first year of implementation.

Given the potential scope for adjusting monitoring equipment and systems to reduce monitoring costs in other industrial sectors, it would be useful if the petroleum refineries would report on the actual capital and operating costs they incurred during the period of the regulation. This information could help to improve future monitoring programs.

3.11 Financial Impacts of Monitoring Costs

The oil companies intend to spend more than what may be strictly required to comply with the monitoring regulations. If production efficiencies are not realized from these monitoring expenditures, then and the companies assert that there will be none, then the extra costs will serve only to reduce profit and return on investment to refining assets.

Although there are no published disaggregated financial or production data on Ontario refineries, there are statistics on the petroleum products segments for each company, except Petrosar.

The financial data on the five other firms are a consolidation of each company's petroleum operations, not just the Ontario facilities.

As discussed in Section 1.4, the monitoring capital cost estimate for each refinery was computed as the percent of the lowest annual capital expenditure between 1981 and 1985. This quotient indicates how much of the firm's petroleum segment capital budget would have been required for monitoring in that year.

Another measure of financial impact is the percentage by which the extra operating costs would reduce each company's after-tax profits (or increase losses) for the petroleum products segment of the company's business. The monitoring estimates were compared with the total after-tax earnings (profits) over five years (1981-1985) and against the lowest positive profit during this same period.

TABLE 3.6

FINANCIAL IMPACTS OF ESTIMATED MONITORING COSTS ON THE CONSOLIDATED PETROLEUM PRODUCTS SEGMENT OF PETROLEUM COMPANIES

Company	Lowest Annual Capital Expenditure since 1981 for Petroleum Products Segments ($ Millions)		Point Estimate Capital Expenditure for Monitoring as a % of Total Capital Expenditure (%)	After-Tax Earnings (Loss) between 1981 and 1985		Total Operating Costs (with Contingencies) as a % of After-Tax Earnings (Loss)	
				Total Earnings for 5 Years ($ Million)	Lowest Positive Earnings during the period ($ Million)	Total for 5 years (%)	Lowest Positive Earnings (%)
Esso	129	(1984)	0.30	776	61 (1983)	0.04	0.5
Petro-Canada	80	(1981)	0.16	1,033	88 (1982)	0.06	0.7
Shell Canada	40	(1985)	0.74	349	23 (1983)	0.08	1.4
Suncor	28	(1985)	1.86	64	1 (1984)	0.5	32.9
Texaco Canada*	59	(1983)	0.06	(25)	39 (1985)	(1.0)	0.6

* Capital expenditure and earnings data only available for 1983, 1984 and 1985

Source: Consolidated annual reports of firms.

Table 3.6 summarizes these measures. The results show that the point estimates of monitoring cost estimates account for less than 1% of total capital expenditures and after-tax earnings for four firms. Although small in comparison to the consolidated earnings of these multi-national corporations, these extra costs can nevertheless have a significant effect on a segment of the firm's business and the plant to which the costs are assigned. The cost estimates are largest in relation to the capital expenditures and after-tax earnings of Suncor which suffered losses in recent years. Texaco Canada also incurred significant losses in 1983 and 1984. Monitoring costs would have increased these losses by about 1%.

The impacts of both capital and operating costs on a firm are mitigated by the tax system. Because all or a part of these costs can be deducted from taxable profits, the federal and provincial governments will incur some of the costs in terms of less tax revenue.

As noted, the monitoring regulation will expire 18 months after it is promulgated. Subsequent annual operating costs could be reduced if the number and frequency of routine analyses, characterization tests and reporting costs are reduced.

The oil companies reported that the added monitoring activities to be undertaken would, in general, be performed by existing staff and that no new permanent jobs would be created as part of the compliance programs.

On the other hand, some monitoring expenditures will be used to purchase equipment and laboratory services from other businesses. Economic activity and some employment will be generated as a result of these expenditures.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The Petroleum Refinery Monitoring Regulation specified requirements for 6 component monitoring activities at each of 7 refineries in Ontario:

- Sampling
- Wastewater flow measurement
- Characterization Analyses
- Routine Analyses
- Toxicity Testing
- Reporting and Administration

Including contingencies and intake water testing, the total operating costs of the monitoring requirements for all seven Ontario refineries were estimated to range between $2.0 million and $2.3 million for 12-months over the 18-month period of the regulation.

The total, one-time capital expenses could range between $1 million and $2 million with a point estimate of $1.6 million. This range is due to a ± 30% uncertainty inherent in the cost estimations. Because of the need for excavation for installation of flow measurement and sampling equipment the higher end of the range is more likely.

In constant dollar terms, operating costs for monitoring are likely to decline in subsequent years because:

- the number and frequency of routine and characterization analyses may be reduced in subsequent years;

- reporting and administration costs will likely decline.

The extra capital costs implied by the "generic" and the refinery monitoring regulations constitute a small proportion of each company's historical annual capital expenditure for the petroleum products portion of their businesses.

The impacts of operating costs on profits for four of the petroleum companies are in the range of one percent or less. One company would have experienced a reduction of as much as 32% of its after-tax profits if the monitoring costs had been incurred in a particularly unprofitable year.

This analysis could not be conducted for Petrosar because no disaggregated financial data are available for this division of Polysar.

4.2 Recommendations

At the end of the regulation period, each refinery should report the actual extra capital and operating costs they incur to implement the monitoring Regulation requirements in order to:

- validate and improve the cost-estimation procedures used in this report.

- monitor and assess the financial and employment impacts of the monitoring requirements.

- help to determine the full financial impact of the MISA requirement.

Finally, when monitoring data and activities at the refineries (and other industrial dischargers) are audited by MOE personnel or their agents, information should be gathered to determine whether the monitoring activities or data have been, or could be, helpful in making the operations or processes more efficient and productive.

REFERENCES

1. Engler, F., MOE, Water Resources Branch, Personal Communication, 1987.

2. Gore and Storrie, "Flow Measurement Systems Costs" Feb. 1987.

3. H.J. Carter, Chairman, Technical Committee of the Ontario Petroleum Association. Letter to Nars Borodczak, Jan. 22, 1988.

4. Maynard, Allan and Young, Dave. "Evaluation of the Petroleum Effluent Monitoring Regulation MIT6: Sampling and Analysis Protocols". A Report to the Petroleum Association for Conservation of the Canadian Environment; Feb. 25, 1987.

5. Moss, Wendy, MOE, Water Resources Branch, Personal Communication, 1987.

6. Ontario, Ministry of the Environment, Economic and Financial Profile of the Ontario Petroleum Refinery Industry - Summary Report. Toronto: Ontario Ministry of the Environment, March 1988.

7. Ontario, Ministry of the Environment, Economic Information Needs and Assessments for Developing MISA Monitoring and Abatement Requirements. Toronto: Policy and Planning Branch, Ontario Ministry of the Environment, March, 1987.

   Ontario, Ministry of the Environment. Inventory and Critical Review of Laboratory Resources, 1988.

8. Ontario, Ministry of the Environment. Municipal-Industrial Strategy for Abatement (MISA). A Policy and Program Statement of the Government of Ontario on Controlling Municipal and Industrial Discharges into Surface Waters. Toronto: Ontario Ministry of the Environment, June 1986.

9. Ontario, Ministry of the Environment. Report on the 1986 Industrial Direct Discharges in Ontario. Toronto: Ontario Ministry of the Environment, October 1987.

10. Ontario, Ministry of the Environment. "The Effluent Monitoring Regulation for the Petroleum Refinery Sector" (Draft), Toronto: Ontario Ministry of the Environment, July 1987.

11. Ontario, Ministry of the Environment, Water Resources Branch, "Refinery Summary", March 1987.

12. Westlake, Dr. G., MOE, Water Resources Branch, Personal Communication, July 1987.